Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/284
UNITED STATES
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

FAST REACTOR SAFETY RESEARCH

Walter J. McCarthy (Power Reactor Development Company)
Karl Cohen (General Electric - APED)
C. E. Dickerman (Argonne National Laboratory)
David Hall (Los Alamos Scientific Laboratory)
A. E. Klickman (Atomic Power Development Associates)
R. B. Nicholson (University of Wisconsin)

At the time of the First Geneva Conference there was concern over the fact that there might be phenomena which were not understood or even recognized, in effect, that fast reactor safety was not well in hand. For example, the cause of EBR-I meltdown was not understood and the magnitude of the energy release to be expected from a defined accident was under question. The situation is quite different today; all aspects of the behavior of EBR-I have been predicted and demonstrated. Indeed, where the physical behavior of the reactor can be described, the nuclear behavior of fast reactors of the type of EBR-II and Fermi can be predicted. The effect of definable reactivity insertions such as movement of control rods, insertion of hydrogenous material, or a "cold slug" event can be predicted, and can be readily handled by adequate design. However, physical alterations which cannot be well described result in reactivity effects which cannot be well predicted. The major circumstances under which it is difficult to predict physical behavior of material movement and the consequent effect on reactivity is when sodium boiling occurs and there are reactivity changes due to sodium void formation and fuel melting. The flow, gravitational, and other forces under this situation are difficult to predict. The nature of this type of problem, the extent of experimental programs to resolve it, and other associated safety research programs are herein reviewed.

For the abnormal reactor condition in which there is a plugged channel or a loss of heat dissipation capability of the heat transport system, the resulting

sodium temperature increase could cause local sodium boiling, loss of sodium, fuel or fuel clad melting, and consequent fuel movement. The fuel behavior in such incidents has been studied out of pile, using simulant materials, and in-pile, by performing experiments on pins in TREAT. These experiments have lead to a basic understanding of fuel behavior under certain abnormal circumstances. The feasibility of a facility for performing large meltdown experiments has been studied. Such a facility would permit the meltdown of large portions of a reactor core in order to get a more comprehensive picture of sodium void formation, fuel motion, and their effects on reactivity.

In order to determine the theoretical upper limit hazard potential of the fast reactor, a number of studies of the maximum accident have been made. The type of accident analyzed is one in which there is rapid fuel rearrangement under the most severe conditions consequent to a possible but probably not plausible set of circumstances. The most recent analyses take into account the Doppler effect which can be expected. The results obtained indicate that the energy release is substantially less than predicted by earlier analyses.

Although the existing small fast reactors have negative sodium void coefficients, it has been found that large fast reactors of certain designs might have positive sodium temperature coefficients. In order to fully assess the potential of this problem, studies have been made on the stability of fast reactors with positive sodium temperature coefficients and negative structure temperature coefficients. Also, studies have been made on the excursion which might occur upon expulsion of sodium from a reactor with a positive sodium void coefficient and a negative Doppler coefficient. More recently the AEC has supported four studies on 1000MW(e) fast breeder reactor systems in an effort to determine the real degree of difficulty which may result from effects upon reactivity of sodium in such large reactors.

The program of fast reactor safety research in the U. S. in recent years has produced a better understanding of the problems, some refinement of the methods of analysis of the problems, qualitative solutions for some of them, and a much better grasp of the severity of these problems.